Noninsulin-Dependent Diabetes

U.S. DEPARTMENT OF
HEALTH AND HUMAN SERVICES
Public Health Service
l Institutes of Health

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National Institutes of Health

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In many cases, weight control alone can control noninsulin-dependent diabetes.

Introduction

Ten million Americans—about 1 in 20—have diabetes. Over 90 percent of these people have a form of the disease called *noninsulin-dependent diabetes.* This kind of diabetes begins in adulthood. Because the symptoms of this disease can be mild, about half of the people who have noninsulin-dependent diabetes don't know it. Over time, however, diabetes can slowly damage the heart, blood vessels, eyes, kidneys, and nerves. The damage can occur even in someone who is not aware that he or she has the disease.

Treatment can control noninsulin-dependent diabetes, and, most experts feel, reduce the chances that these harmful changes or complications will threaten health. In many cases, weight control alone can control diabetes. However, the treatment that exists now is not a cure. Until a cure is found, treatment must continue throughout a person's life.

For this reason, day-to-day treatment is largely up to the person with diabetes, working with a doctor's advice. Treatment is most successful when the person with diabetes understands the disease and how to treat it, and why treatment can preserve health.

This booklet is about noninsulin-dependent diabetes. It is not a guide to treatment and does not replace the advice of a doctor. Only a doctor who has seen someone in his or her office and has access to medical tests and records can suggest treatment. This booklet is one of many sources of extra information about diabetes. Local diabetes groups and clinics also sponsor meetings and educational programs about diabetes and how it is treated. These programs can be a rich resource through which people with diabetes can learn about

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This booklet is about *noninsulin-dependent diabetes.* The word "diabetes" in the text of this booklet refers to noninsulin-dependent diabetes unless otherwise specified.

the disease from health experts and from other people who have diabetes. A resource list at the back of this booklet has a list of groups that can direct someone with diabetes to such programs.

Points to Remember

- *Noninsulin-dependent diabetes is more common than most people realize.*
- *Treatment can control noninsulin-dependent diabetes, reduce the likelihood of long-term problems from this disease, and increase the chances of a long, healthy life.*

What is Diabetes?

There are two major types of diabetes—*insulin-dependent* and *noninsulin-dependent.* Over 90 percent of people with diabetes have noninsulin-dependent diabetes, the kind this booklet is about.

These two types of diabetes are different diseases. This distinction is not always clear in news reports and magazine articles on diabetes. The causes, short-term effects, and treatments for the two diseases differ. At the same time, both diseases can cause the same long-term health problems.

Both kinds of diabetes affect the body's ability to use digested food for energy. Diabetes does not interfere with digestion. Instead, it prevents someone's body from using an important product of digestion—glucose—for energy.

Glucose is a form of sugar. (Table sugar or sucrose is a combination of glucose and another kind of sugar, fructose.) After a meal, the body digests or breaks down some food into

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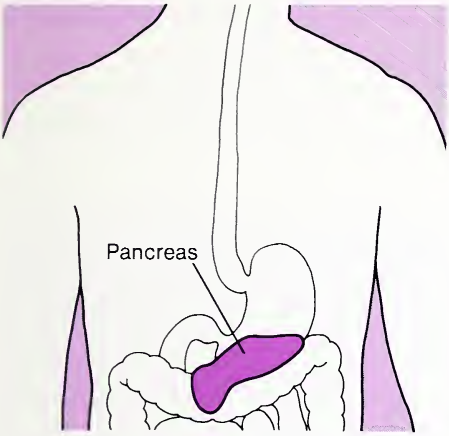


glucose. Circulating blood carries the glucose all over the body. When some part of the body needs energy, it metabolizes, or, in a manner of speaking, burns the glucose for fuel.

For body tissues to metabolize glucose for energy, a substance called insulin must be present. Insulin is a hormone, one of many the body produces. Some hormones control how quickly children grow in height and when they begin to mature sexually. Other hormones affect how fast a person's heart beats and the level of blood pressure.

The hormone insulin makes it possible for the body to use glucose in blood for energy. Insulin is made by a gland called the pancreas located just below the stomach. The pancreas responds to the amount of glucose in blood. After a meal, the amount of glucose present in blood increases. In response to this increase, the pancreas secretes enough insulin to permit body tissues to use the glucose required for energy, and store what is left for future use. Glucose can be stored in the liver or in muscle in the form of glycogen—a substance made up of chains of sugar molecules—or in the form of fat.

In someone with diabetes, this process does not work properly. The reason depends on whether the diabetes is insulin-dependent or noninsulin-dependent. In people with insulin-dependent diabetes, the pancreas fails to produce insulin. We don't yet understand how this happens. This condition usually begins in childhood and is sometimes called type I or juvenile-onset diabetes. People with this kind of diabetes must have daily insulin injections in order to survive.

In people with noninsulin-dependent diabetes, on the other hand, the pancreas usually continues to produce at least some insulin, but the insulin fails to limit the level of blood glucose. When insulin is present, but does not keep blood glucose normal, the condition is called insulin resistance. Insulin resistance is an important factor in noninsulin-dependent diabetes.

Noninsulin-dependent diabetes is also called type II or adult-onset diabetes. The disease most often begins in a person's adult years. It may begin gradually and can escape notice for some time. When noninsulin-dependent diabetes is diagnosed in someone, the disease can very often be treated with diet and exercise.

Points to Remember

- *Diabetes interferes with the body's use of food for energy.*
- *Most people with diabetes have noninsulin-dependent diabetes, which is different in many ways from insulin-dependent diabetes. At the same time, insulin-dependent and noninsulin-dependent diabetes can cause the same long-term health problems.*

Symptoms

The symptoms of noninsulin-dependent diabetes can be vague. They may include fatigue or an ill feeling, frequent urination, especially at night, and unusual thirst.

Frequent urination is one way the body gets rid of excess glucose. Loss of fluid leads to thirst.

Other symptoms that may occur with diabetes are sudden weight loss, blurred vision, and slow healing of infections of the skin, gums, and urinary tract. Women may notice itching in the genital area.

It is also possible to have diabetes without any symptoms, or with symptoms that may begin so gradually that they are easy to ignore. In this case, a doctor may first suspect diabetes if a person has health problems that are often linked to diabetes. For instance, heart disease, numbness in the feet and legs, or sores in these areas that are slow to heal may prompt a doctor to check for diabetes.

Of course, some people who have these symptoms may not have diabetes. If you or someone you know has these complaints, a doctor should be able to determine exactly what is causing the problems.

Points to Remember

- *The symptoms of noninsulin-dependent diabetes can be subtle.*
- *The symptoms of diabetes include fatigue or a feeling of illness, great thirst, frequent urination, sudden weight loss, blurred vision, slow healing of infections, and genital itching.*

What Causes Noninsulin-Dependent Diabetes?

There is no simple answer for what causes noninsulin-dependent diabetes. Eating lots of sugar, for example, does not in itself cause diabetes. Eating lots of sugar, like eating other rich, fatty foods, can cause weight gain. Most people who develop diabetes are overweight. Obesity is a major factor in noninsulin-dependent diabetes.

At one time, doctors thought that diabetes was always caused by too little insulin. Eventually scientists found that this was true for one kind of diabetes—insulin-dependent—but that most people with diabetes could continue to make insulin. This group of people has noninsulin-dependent diabetes.

In people with noninsulin-dependent diabetes, the insulin that is present does not lower blood glucose as it should, a condition called insulin resistance. Scientists are still searching for why this happens. There are at least two possibilities.

One possible cause of insulin resistance is a problem with insulin receptors on the surfaces of cells. Insulin receptors are locations on cells to which insulin must bind to have any effect. Like an electrical appliance that needs to be plugged into an outlet in order to work, insulin has to bind to a receptor to function.

Several things can go wrong with receptors. In some cases, there may not be enough receptors for insulin to bind to. A defect in the receptors may keep insulin from binding.

A second possible cause of insulin resistance involves what happens after insulin plugs into the receptor. In some cases, insulin binds to the receptor, but the next steps that should occur inside the cell do not. Even with insulin bound to its receptor, the cells do not carry out the job of using glucose. Scientists are now studying the inner workings of cells to see why this might happen.

Being overweight increases a person's chances of having diabetes. Obesity is a very important factor in noninsulin-

dependent diabetes. At this time, however, scientists do not yet fully understand why obesity increases someone's chances of developing diabetes.

Scientists should have the answers to these questions in the next few years. This research will help answer why diabetes occurs and why obesity is such an important factor in the disease.

Points to Remember

- *No one knows for sure exactly what causes diabetes in every case.*

Who Develops Noninsulin-Dependent Diabetes?

Age, sex, weight, physical activity, diet and lifestyle, and family health history all affect someone's chances of developing diabetes. For example, 80 percent of people who find out that they have diabetes are overweight. Someone who is overweight has a greater chance of developing diabetes than someone who is slim. For this reason, excess weight is called a risk factor for diabetes. On the other hand, most overweight people will never develop diabetes and some slim people will. Excess weight, therefore, is not the only risk factor for diabetes.

The chances that someone will one day develop diabetes are increased if his or her parents or a brother or sister have the disease. A family history of diabetes is therefore a risk factor for diabetes.

Diabetes is more common in blacks and hispanics than whites. It is not clear whether this is the result of heredity, *Women are about as likely as men to develop diabetes.*

factors in the environment such as diet, or both types of factors. The highest rate of diabetes in the world is found in an Arizona community of American Indians.

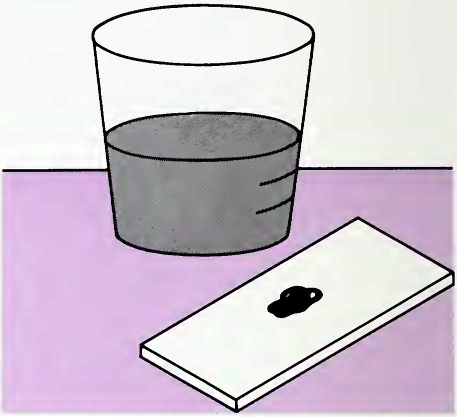
In this country, women are about as likely as men to develop diabetes. The chances of developing diabetes increase as a person gets older. No one can change his or her family history, age, or race. However, it is possible to control weight and physical fitness. A doctor can assess whether someone is at risk for diabetes and, if so, how to lower the chances of developing the disease.

Points to Remember

- *The following factors increase someone's chances of one day developing diabetes: excess weight, family history of diabetes, advancing age.*

How a Doctor Diagnoses Diabetes

A doctor can look for diabetes by noting symptoms such as thirst and frequent urination and by running tests that measure the amount of glucose in urine or blood.



A number of different tests can detect diabetes. A urine test measures glucose in urine. Glucose in urine can be a sign of diabetes because when blood glucose rises above a certain point, the kidneys eliminate the excess glucose in urine.

A blood test measures glucose in blood. A blood test can be done in the morning before

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breakfast (fasting glucose test) or after a meal (postprandial glucose test).

The oral glucose tolerance test is also a blood test for diabetes. In some cases, a glucose tolerance test can detect diabetes even when a simple blood test does not. In this test, blood glucose is measured before and after the person being tested has consumed a liquid that tastes like a very sweet, thick soft drink. The drink has a measured amount of glucose and sometimes other sugars in it.

The oral glucose tolerance test measures how the body responds to an increase in blood glucose after eating. Normally the amount of glucose in a person's blood rises quickly in response to a meal and then falls gradually again as insulin goes to work helping the body use the glucose.

With diabetes, however, blood glucose may be high all the time. Or, the blood glucose level may be within the normal range much of the time, but after a meal it may rise much higher than normal.

A doctor will decide, based on these tests and a physical exam, whether someone has diabetes. Treatment depends on how severe the diabetes is. If a blood test is only slightly abnormal, the doctor may want to monitor blood glucose periodically in the future. If a person is overweight, he or she will probably be advised to lose weight. The doctor may also keep track of the condition of someone's heart, because diabetes increases the risk of heart disease.

Points to Remember

A doctor will diagnose diabetes by looking for four kinds of evidence:

- *factors that make diabetes more likely, like excess weight and the presence of diabetes in the family*
- *symptoms of diabetes, like thirst and fatigue*
- *complications of the disease, like heart trouble*
- *signs of glucose or sugar in blood or urine tests.*

How Noninsulin-Dependent Diabetes is Treated

The goals of diabetes treatment are to keep blood glucose within a normal range and to prevent the complications of diabetes.

Why control blood glucose? In the first place, diabetes can cause short-term effects that are unpleasant and sometimes dangerous. These include thirst, frequent urination, weakness, lack of ability to concentrate, loss of coordination, and blurred vision. Loss of consciousness is possible with very high or low blood sugar levels but it is more of a hazard in insulin-dependent than in noninsulin-dependent diabetes.

In the second place, many experts feel that the long-term complications of diabetes result from years of high blood glucose. Research is under way to confirm this in human patients and to find to what extent careful control of diabetes will help prevent complications. In the meantime, most doctors feel that if people with diabetes are careful to try and control blood glucose levels, they will reduce the risk of complications from this disease.

A National Institutes of Health expert panel in 1986 recommended that the basis of treatment for noninsulin-dependent diabetes was diet aimed at keeping someone at normal weight. In people who are overweight, losing weight is the one treatment that is clearly effective in keeping diabetes under control. In some people,

Diet aimed at weight control is the mainstay of diabetes treatment.

exercise can help weight and diabetes control.

When diet and exercise alone do not control diabetes, two other kinds of treatment are available: oral diabetes drugs or insulin injections. The treatment that a doctor suggests for someone with diabetes depends on the person's age, lifestyle, and how severe the diabetes is. A doctor may suggest more than one approach to treatment to find one that works well. Treatment for diabetes works best when the person with diabetes, working with his or her doctor, achieves a balance between diet and exercise and any necessary medication, such as oral drugs and insulin.

By following a doctor's advice, someone with diabetes can control the disease and lower the chances of having related problems like heart disease. Treatments now used for diabetes do not cure the disease but control it. For treatment to be effective, it must continue throughout the life of the person with diabetes.

Points to Remember

- *Diabetes should be treated to avoid unpleasant symptoms, like thirst and weakness, and to reduce the chances of long-term problems, like heart and eye disease.*
- *Diet aimed at weight control is the mainstay of diabetes treatment. Exercise can sometimes help weight and diabetes control. If diet and exercise are not effective alone, oral drugs and insulin may be used.*
- *The best treatment balances any different treatments being used.*
- *There is no known cure for diabetes—treatment must continue throughout a person's lifetime.*

Diet

Diet is a mainstay of diabetes treatment. A diet can help someone with diabetes:

- Achieve and maintain desirable weight. Many people with diabetes could control the disease by keeping their weight under control.
- Avoid extremes of blood glucose.
- Limit foods that may contribute to heart and blood vessel disease. These conditions are more frequent in people with diabetes than in those without.

Although doctors prescribe diet as a part of diabetes treatment, they cannot always take the time or have the knowledge of diet planning needed to design a personalized diet for someone. A professional who is knowledgeable about both diabetes and diet can design a diet that is healthy, but at the same time appealing and flexible, with foods that are tasty as well as healthy. No one has to be limited to a preprinted, standard diet. Someone with diabetes can get assistance in the following ways:

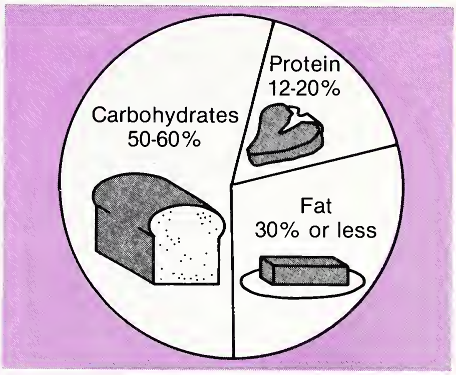
- A doctor may be able to recommend a local nutritionist or dietitian with knowledge of diabetes.
- The local American Diabetes Association, American Heart Association, or American Dietetic Association may be able to offer names of qualified dietitions or nutritionists.

- The above organizations can provide or refer someone to printed information on diet that is helpful in understanding the principles behind designing a diet for diabetes.

- It may be possible to find a local diabetes center with a staff dietitian or nutritionist at a large medical clinic, hospital, or medical university. A regional center, such as at a medical university, may be able to recommend local resources in a community.

Among the guidelines used to shape a diet for diabetes are the following:

- Many experts, including the American Diabetes Association, recommend that someone consume 50 to 60 percent of their daily calories as carbohydrate, 12 to 20 percent as protein, and no more than 30 percent as fat.
- Spacing meals through the day rather than eating heavy meals once or twice a day, can help avoid extremes of blood glucose.
- With few exceptions, the best way to lose weight is gradually, for example, one or two pounds a week. Very restrictive diets must never be undertaken without the supervision of a doctor.



- People with diabetes have twice the risk of heart disease as those without diabetes. Diabetes raises the risk that someone will develop heart disease. High blood cholesterol level raises the risk of heart disease. Losing weight can help lower blood cholesterol as will limiting saturated fats and cholesterol in the diet in favor of unsaturated and monounsaturated fats. (Meats and dairy products are the major sources of saturated fats; most vegetable oils are high in unsaturated fats, and olive oil is a good source of monounsaturated fat. Organ meats and egg yolks are particularly high in cholesterol.) A doctor or nutritionist can advise someone on this aspect of diet.

- Fiber is a form of indigestible food from plants. Fruits and vegetables (especially with their skins), peas and beans, and foods made with whole grains are high in fiber. Studies have shown that fiber may help limit blood glucose. However, it appears that this helpful effect requires that a person eat much more fiber than the average American now consumes. A doctor or nutritionist can advise someone on adding fiber to a diet.

Exchange lists are a frequently used framework for a diet for diabetes. Exchange lists place foods that offer similar nutrients and calories (energy) into groups. With the help of a nutrition counselor, a person on a diet plans the number of servings or exchanges from each exchange list he or she should have during the day to maintain a certain calorie level. The person can then choose any of the foods within each exchange list to fulfill that day's quota for that list. Diets that use exchange lists offer a person more choices of different foods than do preprinted diets. More information on exchange lists is available from nutritionists and from the American Diabetes Association.

Continuing research may lead to new approaches to diets for diabetes. For example, foods that are rich in carbohydrates (starches and sugars) are broken down into glucose during digestion. Breads, cereals, fruits, and vegetables contain carbohydrates. After consumption of these foods, blood glucose rises. Research is showing, however, that it is more difficult than was once thought to predict to what extent different carbohydrates will affect blood glucose level. Because one of the goals of a diet for diabetes is to avoid extremes in blood glucose level, it would be helpful to have reliable information on the effects of foods on blood glucose. For example, research is testing the concept that foods with sugar raise blood glucose more than foods with starch.

In order to answer this question, scientists are studying how foods affect blood glucose. The “glycemic index” is a way of describing how much a food affects blood glucose in comparison with the effect of consumed glucose on blood glucose. Much more information on the effects of foods on blood glucose is needed before this information can be used as a basis for diet planning. We know that, in general, raw, unpeeled foods will raise blood glucose less than foods that have been mashed and cooked a long time. Someone with diabetes may want to ask a doctor or nutritionist about the glycemic index of foods and whether this kind of information may be helpful to use in diet planning.

Alcohol

Most people who have diabetes can drink alcohol safely if they are cautious. On the other hand, too much alcohol can cause special problems for someone with diabetes:

- One problem is that alcohol has calories without the vitamins, minerals, and other nutrients that are essential for maintaining good health. The calories in alcohol must be taken into account when someone is trying to limit his or her calorie intake.

JUST ONE FOR ME!

- Alcohol on an empty stomach can lead to low blood glucose or hypoglycemia. Hypoglycemia is a particular risk in people who use oral drugs or insulin for diabetes. Severe hypoglycemia can cause shaking, dizziness, and collapse. People who don't know of someone's diabetes may take these symptoms for drunkenness and neglect to seek medical help.
- Two oral diabetes drugs—tolbutamide and chlorpropamide—can cause dizziness, flushing, and nausea when they are combined with alcohol. A doctor can advise someone who takes these drugs on the safety of drinking.
- One of the most important functions of the liver is its role in storing and releasing energy in the form of glucose. A liver damaged from drinking can add to the problem of blood glucose control that a person with diabetes already has.
- Frequent heavy drinking can raise the levels of fats in blood. High blood fat levels increase the risk of heart disease.

A doctor can discuss whether it is safe for an individual with diabetes to drink. A dietitian can also provide information on the sugar and alcohol content of various alcoholic drinks.

Points to Remember

- *A diabetes diet should do three things: achieve ideal weight; avoid high blood glucose; and limit foods that contribute to heart disease.*
- *A diabetes diet can be planned for a person by a nutritionist or dietician.*

A thorough physical exam by a doctor is essential before starting an exercise program.

Exercise

Exercise has many benefits. For someone with diabetes, exercise together with diet can often control diabetes.

First, exercise uses calories. Using extra calories helps control weight.

Regular exercise can also improve the body's response to the hormone insulin. As a result, exercise can make oral diabetes drugs and insulin more effective and can help keep the level of glucose in blood under control.

Third, regular, sustained exercise reduces some risk factors for heart disease. For example, exercise can lower the amount of fats and cholesterol in blood, both of which increase heart disease risk. Exercise increases the amount of one kind of cholesterol, HDL cholesterol, that reduces heart disease risk. Exercise can reduce blood pressure and the amount the heart has to work during exercise and at rest.

Abrupt, strenuous exercise can strain muscles and the circulatory system and can increase the risk of a heart attack during exercise. A thorough physical exam by a doctor is the only way to find out whether it is safe to exercise. The doctor can determine how well controlled a person's diabetes is, the condition of the heart and circulatory system, and whether diabetic complications are present that may make certain kinds of exercise unwise.

Someone who has not been active can, for example, walk for 15 or 20 minutes, three or four times a week. If desired, the speed or distance of the walks or the frequency of the exercise can be increased over several weeks.

The goal in exercise is to have some kind of physical activity that a person will enjoy and do regularly, at least several times a week, for many years. It does no good to do very hard exercise for 6 months and quit.

Strenuous exercise can lower blood glucose too much in someone who is taking oral diabetes drugs or insulin. Someone who is exercising can carry a food or drink with sugar in it to take if he or she senses signs of low blood sugar or hypoglycemia. These signs include nervousness, shakiness, weakness, sweating, headache, blurred vision, and hunger. Another precaution is a bracelet that tells that the wearer has diabetes. An identification bracelet will alert a stranger that the wearer has diabetes and may need special medical help when ill or injured.

A doctor may advise someone with high blood pressure or complications of diabetes such as problems affecting the blood vessels of the eyes, to avoid exercise that raises blood pressure. Lifting heavy objects, exercises that make someone strain against very heavy or immobile objects, and exercises that strain the upper body raise blood pressure.

People who have lost sensitivity in their feet from diabetes can enjoy exercise and also protect their feet by choosing shoes carefully and checking their feet for breaks in the skin. Swimming or bicycling can be easier on the feet than running.

A doctor can answer questions about the safety of exercise for someone with diabetes.

Points to Remember

- *Exercise has three major benefits: it uses calories, it improves the body's response to insulin, and it reduces risk factors for heart disease.*
- *Exercise should be started slowly and with the advice of a doctor.*

Oral Drugs

Oral diabetes drugs, or oral hypoglycemics, can lower blood glucose in people who have diabetes, but who are able to make some insulin. Oral hypoglycemics are an option if diet and exercise fail to control diabetes.

Oral diabetes drugs are not oral insulin. Insulin cannot be taken by mouth because it would not survive the digestive tract—that is why it has to be taken by injection.

Oral drugs are not a substitute for diet and exercise. They are effective only in people whose diet and weight are under control.

Experts do not understand exactly how each oral drug works. The drugs can increase the amount of insulin produced and they may also affect how insulin acts to lower blood glucose.

Oral diabetes drugs are most likely to be useful in people who developed diabetes after the age of 40 and who have had diabetes less than 5 years, who

Oral diabetes drugs are not oral insulin.

are normal weight or somewhat overweight (not underweight or grossly obese), and who have never received insulin or have not required more than 40 units of insulin a day.

Oral drugs are not recommended for a woman who is pregnant or nursing. The effect of these drugs on an infant are unknown. In addition, insulin can provide better control of diabetes during pregnancy.

You may have heard that there is some question as to whether oral diabetes drugs increase the risk of a heart attack. However, experts disagree on this point. Oral drugs are still prescribed for many people with noninsulin-dependent diabetes.

The Food and Drug Administration (FDA), the agency of the Federal Government that approves drugs for use in this country, requires that oral diabetes drugs carry a warning with regard to the increased risk of heart attack. Whether or not someone uses a drug depends on its benefits and risks, a subject that a doctor can put into perspective.

Six FDA-approved oral diabetes drugs are now on the market. Their generic names are tolbutamide, chlorpropamide, tolazamide, acetohexamide, glyburide, and glipizide. The generic name refers to the chemical that gives each drug its particular effect. Some of these drugs are made by more than one drug company and as a result have more than one brand name in addition to the generic name.

All six drugs are different types of one class of drug, called sulfonylureas. The drugs differ somewhat in how they affect someone's metabolism. It is best to discuss these specifics with a doctor.

Experience with the newer versions of these drugs—glyburide and glipizide—will show how these drugs compare in effectiveness with the older drugs.

A doctor will choose a drug for someone with diabetes based on the person's general health, how much his or her blood glucose needs to be lowered, the person's eating habits, and any side-effects the drug has.

Side effects of oral drugs are reported to be infrequent. Because the drugs lower blood glucose, someone taking oral drugs needs to be careful about doing other things at the same time that also lower blood sugar, such as skipping meals and exercising long and hard. Some drugs taken for other purposes can also lower blood sugar—a doctor should be consulted to ensure that drugs will not react with each other in a harmful way.

Lowering blood sugar too much—a condition called hypoglycemia—will result in symptoms like headache, weakness, shakiness, and if the condition is severe enough, collapse.

Oral diabetes drugs can cause symptoms like nausea, skin rashes, headache, either water retention or diuresis (increased urination), and a variety of other side effects. Someone taking the drugs may be more sensitive to direct sunlight. Sometimes the effects will subside with time. A doctor should be consulted for advice if they persist.

For reasons that are not always clear, oral diabetes drugs sometimes fail to help some people for whom they are prescribed. In some cases, the drugs fail in people who are helped at first by the drugs. Research is continuing on how these drugs work and why, in some cases, they don't work.

Points to Remember

- *Oral diabetes drugs may be used when diet and exercise alone do not control diabetes.*
- *Oral diabetes drugs are not a substitute for diet and exercise.*

Weight control is important for insulin to be effective.

Insulin

Like oral diabetes drugs, insulin is an alternative for some people with noninsulin-dependent diabetes who cannot control their blood glucose level with diet and exercise. In certain special situations, such as surgery and pregnancy, insulin is an important, and usually temporary, means of controlling blood glucose level.

When diet and exercise have failed to control diabetes, doctors decide which treatment to try next on a case-by-case basis. Sometimes it is not clear cut whether insulin or oral drugs are best. Someone's weight, age, and the severity of his or her diabetes make a difference in this decision. In addition, the viewpoint of the doctor toward the use of oral drugs versus insulin can affect this decision. Experts disagree in some cases on which treatment, if either, is more effective.

A doctor is likely to prescribe insulin if neither diet, exercise, or oral drugs work, or if someone has an adverse reaction to oral drugs. In addition, someone may have to take insulin if his or her blood glucose fluctuates a great deal, in a way that is difficult to control.

Weight control is important for insulin to be effective. Insulin does not free someone from the need to follow a diet.

A doctor who prescribes insulin will instruct a person with diabetes on how to purchase, mix, and inject insulin. There are a number of different types of insulin available that vary in purity, concentration, and rapidity of action.

They also vary as to where they come from. In the past, all commercially available insulin was extracted from the pancreas glands of cows and pigs. Human insulin is now available in two forms, one made using genetic engineering and one that involves chemically changing pork insulin to human insulin.

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The best source of information on all the many aspects of using insulin is a doctor. The American Diabetes Association has general information on insulin that may also be useful. The association's address is in the resource list at the end of this booklet.

Even people who can control their diabetes with other means besides insulin may need insulin at certain times. A section of this booklet called "special situations" describes how insulin is used in a pregnant mother and for surgery.

Points to Remember

- *Insulin may be used when diet, exercise, or oral drugs do not control diabetes.*
- *Weight control is important when insulin is used.*
- *Insulin is used in special situations such as surgery and pregnancy.*

Keeping Track of Glucose Levels

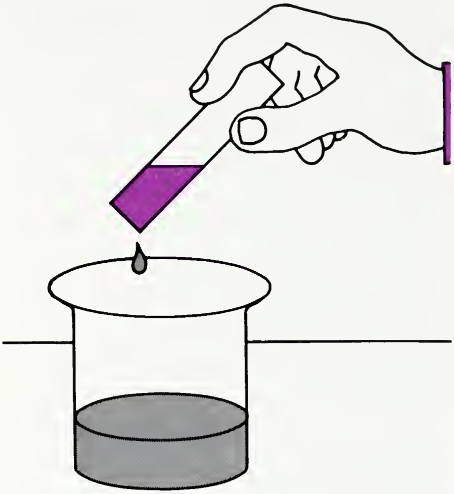
When someone's body is operating normally, it automatically monitors the level of glucose in blood. If blood glucose gets too high or too low, the body will adjust how it uses or removes the sugar to bring the level back to normal. This system operates in much the same way that cruise control adjusts the speed of a car.

With diabetes, the body does not do the job of controlling blood glucose automatically. To make up for this, someone with diabetes has to keep track of blood glucose and adjust treatment to bring blood glucose back to normal.

A doctor can measure blood glucose during an office visit. However, blood glucose level varies day to day and hour to hour. Someone who visits the doctor only every few weeks won't know how his or her blood glucose is day to day.

Do-it-yourself tests provide a way to know what blood glucose is each day. The easiest test

Urine testing is not the best way to monitor diabetes.



someone can do at home is a urine test. When the level of glucose in blood reaches a certain point above normal, the kidneys try to get rid of the excess glucose in urine. Glucose in urine, therefore, reflects an excess of glucose in blood.

Urine testing is easy. Tablets or paper strips dipped in urine change color. A color chart shows whether or not there is glucose present. However, urine testing is not the best way to monitor diabetes. A measurement of glucose in urine actually reflects a high level of blood glucose a few hours earlier.

In addition, not everyone's kidneys work in exactly the same way. Even when the amount of glucose in two people's urine is the same, their blood glucose levels may be different.

Finally, certain drugs and vitamin C can affect the accuracy of urine tests.

It is more accurate to measure blood glucose directly. There are a number of kits on the market that allow people with diabetes to test their blood glucose at home. The test involves pricking a finger to draw a drop of blood. A spring-operated ''lancet'' will do this automatically. A strip of special paper moistened by the blood drop changes color and in this way tells how much glucose the blood contains. The color strips can be read using a chart, or with a small device that will read the strip automatically.

A doctor may suggest that someone test his or her blood glucose several times a day. Self blood glucose monitoring can show how the body responds to

meals, exercise, stress, and diabetes treatment.

A doctor can perform another test that will measure how well treatment has been working for the past few months. This test measures the amount of glucose that has become attached to hemoglobin, the molecule in red blood cells that gives blood its red color. Over time, hemoglobin exposed to glucose in blood will take up some of the glucose. How much glucose becomes attached depends on the concentration of glucose in blood. Once glucose becomes attached to the hemoglobin molecule in blood cells, it remains attached until the blood cells die and are replaced with new blood cells.

Using a ‘‘glycosylated hemoglobin’’ test, a doctor can tell whether blood glucose has been very high over the last few months. A doctor can best explain what particular results mean for a glycosylated hemoglobin test.

Points to Remember

- *Keeping track of blood glucose level is an important way to know how well diabetes treatment is working.*

Complications

A key goal of diabetes treatment is to prevent the complications of this disease. Diabetes can, over time, damage the heart, blood vessels, eyes, kidneys, and nerves. Someone with diabetes may not be aware at first that the damage is taking place. Diabetes is like high blood pressure in this way. It is important to treat diabetes, because, like high blood pressure, it can cause damage even before it makes someone feel ill.

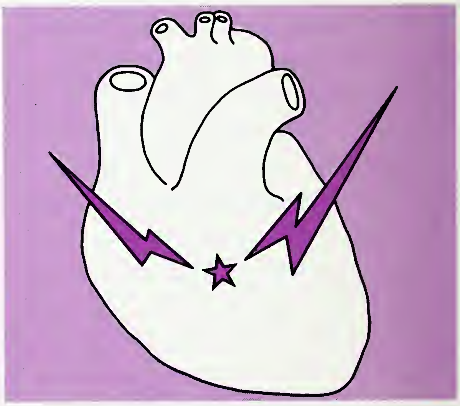
How diabetes causes long-term problems is not yet clear. However, certain changes in small blood vessels and nerves are very common in people with diabetes. These changes are thought to be the first step in many of the problems that diabetes causes.

Scientists are not yet able to predict who, among people with diabetes, will have complications and what the chances are that someone will have such problems. While complications are most likely to appear in someone who has had diabetes for many years, a person can have diabetes without knowing it. A complication may be the first sign.

At this time, health care that includes identification and treatment of diabetes is the only means known by which people who have diabetes can reduce the risk of complications.

Heart

Heart disease is the most common life-threatening disease linked to diabetes. Diabetes doubles someone's risk of heart disease.



In coronary heart disease the arteries supplying the muscle of the heart with blood become narrowed by deposits of fat and

Diabetes doubles the risk of heart disease.

cholesterol. If the narrowing decreases the blood supply to the heart too much, the heart muscle can be damaged. The damage, in the form of a heart attack, can be fatal.

Scientists do not yet understand why diabetes adds to the risk of developing heart disease. Other risk factors for heart disease include hypertension or high blood pressure, obesity, high amounts of fats and cholesterol in blood, and cigarette smoking. Taking action to reduce the impact of these risk factors, along with treating diabetes, can reduce the risk of heart problems.

The American Heart Association has publications that explain heart disease and how to prevent it. The association's address is listed in the resources section of this booklet.

Kidneys

Kidney disease is another condition that affects people with diabetes more frequently than others. The kidneys filter waste products from blood and get rid of them in urine. In this way also, the kidneys maintain the proper fluid balance in the body. The kidneys are essential. People can live without one kidney, but those without both must have special treatment, dialysis, to fill in for the function of the kidneys.

Most people with diabetes will not be affected by kidney disease. Treatment for diabetes can help reduce further the chances of kidney damage. Someone with diabetes can also watch for other factors that might add to the risk of kidney disease. High blood pressure, for example, can increase the risk of kidney trouble. Regular blood pressure checks and treatment, if high blood pressure is diagnosed, can help prevent kidney disease.

Urinary tract infections can also affect the kidneys. Urinary tract infections occur when bacteria grow in the bladder, the tubes leading from the kidney to the bladder, and the tubes from the bladder to the outside of the body. Sometimes diabetes affects the ability of a person to empty his or her bladder completely. This problem occurs because diabetes reduces the effectiveness of nerves that control the bladder. Infections can begin more easily when the bladder cannot be completely emptied.

The symptoms of urinary tract infections include frequent, painful urination, blood in the urine, and pain in the lower abdomen and back. Without prompt examination and treatment by a doctor such infections can reach the kidneys, causing pain, fever, and possibly kidney damage. Antibiotics are used to treat urinary tract infections. A doctor may also suggest that someone with a bladder infection drink more water than usual.

Water retention is a condition in which fluid collects in someone's body and causes swelling, often in the legs and hands. Kidney problems are among the causes of water retention or edema. A doctor can check to see if swelling or water retention is related to kidney function.

A doctor in general practice treating someone with diabetes may suggest a visit to a nephrologist if signs of kidney problems appear. A nephrologist is a doctor who is specially trained to diagnose and treat kidney problems. A nephrologist can identify the cause of any problems and how best to lower the chances of any serious kidney illness.

Eyes

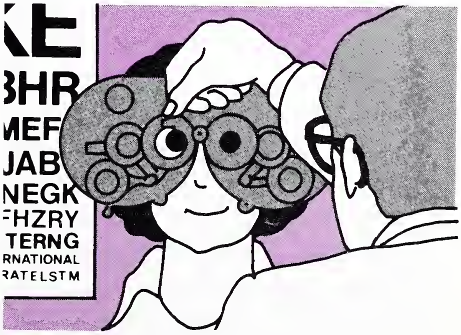
Diabetes can affect the eyes in several different ways. In most cases the effects are temporary or can be helped by better diabetes control. In some cases, however, long-term diabetes can cause changes in the eyes that threaten vision. Good diabetes care and a yearly visit to an ophthalmologist, a medical doctor who is trained to treat eye problems, can help ensure the health of someone's eyes.

Blurry vision is one effect diabetes can have on the eyes. The reason may be that changing levels of glucose in blood can also affect the balance of fluid in the lens of the eye. The lens works like a flexible camera lens to focus images. If the lens absorbs more water than normal and swells, the focusing power of the lens also changes. Diabetes may also affect the function of nerves that control vision, and this may also cause blurry vision. Diabetes treatment can help keep glucose levels stable and help prevent these changes in vision.

Cataract and glaucoma are both eye diseases that can occur in people who do not have diabetes. These problems occur more frequently in people with diabetes than in those without the disease. Cataract is a clouding of the normally clear lens of the eye. Glaucoma is a condition in which pressure within the eye can damage the optic nerve that transmits visual images to the brain. Both of these conditions can be treated. Early diagnosis and treatment of cataract and glaucoma makes successful treatment most likely.

Diabetic Retinopathy

Retinopathy means disease of the retina, the light sensing tissue at the back of the eye. Diabetic retinopathy is a disease of the retina caused by diabetes. Many people who have had diabetes for 25 years or more will have changes in their eyes that can be seen by a doctor. In most people, however, the disease will not seriously affect vision. A yearly eye examination



makes it possible for an eye doctor or ophthalmologist to catch changes before vision is affected and the illness becomes harder to treat.

Diabetic retinopathy causes changes in the tiny vessels that supply the retina with blood. The blood vessels may swell and leak fluid. When retinopathy is more severe, new blood vessels may grow from the back of the eye and bleed into the clear gel that fills the eye, the vitreous.

Treatment for diabetic retinopathy can help prevent loss of vision and can, in some cases, restore vision lost as a result of this disease. A yearly eye exam is the best way to make sure that changes that may threaten vision are diagnosed early and that effective treatment is carried out when it can be most helpful.

High blood pressure may contribute to diabetic retinopathy. Checking for high blood pressure and treating it if it is present can help safeguard vision. There is also evidence that smoking can cause diabetic retinopathy to worsen.

Blurred vision that lasts longer than a day or so, sudden loss of vision in either eye, or black spots, lines, or flashing lights in the field of vision should be brought to the attention of a doctor right away.

Scientists are testing new means of treating diabetic retinopathy. For additional information on eye complications of diabetes and the treatment of these conditions, see the resource list at the end of this booklet.

Legs and Feet

Leg and foot problems can arise in people with diabetes from a combination of changes in the blood vessels and nerves in these parts of the body. Peripheral vascular disease is a condition in which blood vessels become narrowed by fatty deposits. Peripheral vascular disease is more frequent and often more severe in people with diabetes than in others. The disorder can reduce the blood supply to the legs and feet. In addition, diabetes can dull the sensitivity of nerves. Someone with this condition, called peripheral neuropathy, might not notice a sore spot caused by tight shoes or by the pressure of walking. If such a spot is ignored, it can enlarge and become infected. Reduced blood supply from peripheral vascular disease makes healing more difficult.

Proper foot care and regular visits to a doctor can prevent foot and leg sores and help ensure that any that do appear do not become infected and painful. Helpful measures include inspecting the feet daily for cuts or sore spots. Blisters and sore spots are less likely with shoes that fit well and socks or stockings that do not bind. A doctor may also suggest washing the feet daily, filing thick calluses, and using lotions that keep the feet from getting too dry. Shoe inserts and sometimes special shoes can be used to prevent too much pressure on any one part of the foot.

Diabetic neuropathy, or nerve disease, can dull nerves, but it can also be very painful. Someone with painful diabetic neuropathy may feel a burning pain that may be relieved by moving around or that makes it very painful to touch anything. A person with neuropathy may be depressed. Scientists are not sure whether the depression is itself an effect of neuropathy, or if it is simply a response to pain.

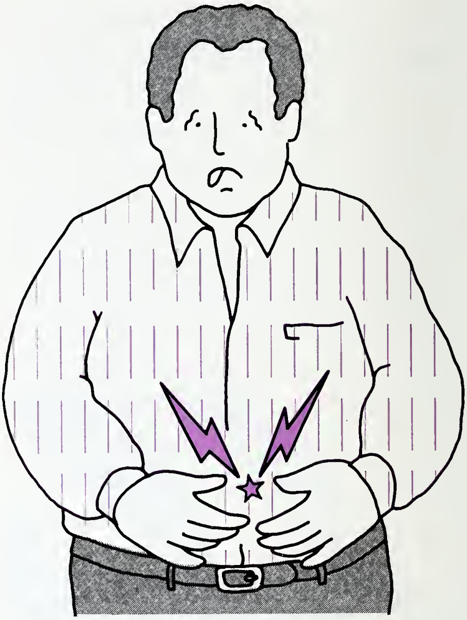
Treatment for painful diabetic neuropathy is aimed at relieving pain and depression. Aspirin and other pain-killing drugs may be prescribed.

A sore on the foot or leg, whether or not it is painful, requires a doctor's immediate attention. Treatment will help heal sores and can help prevent new ones. These problems with the feet and legs are the reason that people with diabetes have amputations—surgical removal of limbs—more often than people without diabetes. Proper care of the feet and legs can prevent ulcers and infections and the more serious problems they can lead to.

Other Effects of Diabetic Neuropathy

Nerves help provide muscle tone and feeling, but they also help control functions like digestion and blood pressure. Diabetes can cause changes in these nerves and the functions they control. These changes and the effects they cause are most frequent in people who have had other complications of diabetes, like problems with their feet.

Someone who has had diabetes for some years, for example, and who has other complications, may find that spells of indigestion or diarrhea are connected with the diabetes. A doctor may prescribe drugs to help these symptoms. Antibiotics are sometimes used to treat diarrhea.



Diabetes over time can affect the nerves that control erection in men. In some men, this can cause impotence that shows up gradually, without any loss of desire for sex. A doctor can find out whether impotence is the result of physical changes, such as diabetes, or emotional changes. On that basis, the doctor can suggest treatment or counseling.

Skin and Teeth

People with diabetes are more prone to infections than people without diabetes. Someone with diabetes may have infections like boils more often than other people. A woman may have vaginal infections that occur more often than in other women. Infections are less likely to become severe if they are treated early. Watching for infections, treating them early, and following a doctor's advice to prevent infections can help make sure that they are mild and infrequent.

Infection can also affect the teeth and gums. Periodontal disease is an inflammation of the tissues that surround and support the teeth. It is a very common problem in people with and without diabetes, and it is a major reason that people lose teeth as they get older. An important cause of periodontal disease is bacterial growth on the teeth and gums. Treating diabetes and following a dentist's advice on dental care can help prevent periodontal disease.

Emergencies

Very high blood glucose levels cause symptoms that for most people are hard to ignore: frequent urination and great thirst. However, someone who is old or in ill health may not be alert enough to notice trouble signs.

Without treatment, a person with high blood glucose or *hyper*glycemia can lose more and more fluid. He or she may become weak, confused, or unconscious. Breathing is shallow and pulse is rapid. The person's lips and tongue will be dry, and his or her hands and feet will be cool. A doctor should be called right away if someone has these symptoms.

The opposite of high blood glucose—very low blood glucose or *hypo*glycemia—is also a danger. Hypoglycemia can occur when someone has not eaten enough to balance the effects of insulin or oral drugs. Prolonged, hard exercise in someone taking oral diabetes drugs or insulin can also cause hypoglycemia, as can alcohol.

Someone whose blood glucose has become too low for some reason may feel nervous, shaky, and weak. The person may sweat, feel hungry, and have a headache. Severe hypoglycemia can cause loss of consciousness. A person with hypoglycemia who is conscious should eat or drink something with sugar in it such as orange juice or sugar cubes. If the person is unconscious, he or she should be taken to a hospital emergency room right away. Identification such as a bracelet that states that the wearer has diabetes, will let friends know that these symptoms are a warning of illness that requires urgent medical help.

Points to Remember

- *Diabetes can cause long-term complications such as heart, kidney, eye, and nerve disease.*
- *Careful treatment of diabetes, and watching out for signs of complications, can lower the chances that someone will be troubled by these conditions.*
- *An identification bracelet stating that the wearer has diabetes can help ensure that friends or strangers won't ignore symptoms that signal a medical emergency.*

This booklet is about *noninsulin-dependent diabetes*. The word "diabetes" in the text of this booklet refers to noninsulin-dependent diabetes unless otherwise specified.

Special Situations

Surgery

Surgery is stressful, both physically and mentally. Stress can raise blood glucose levels and disturb the balance of blood glucose even in someone who is careful about control.

In order to make sure that surgery and recovery are successful for someone with diabetes, a doctor will test blood glucose and keep it under careful control, probably with insulin. Careful control makes it possible for someone with diabetes to have surgery with little or no more risk than someone without diabetes.

In order to plan and carry out surgery safely, the surgeon and attending physicians must know that the person they are treating has diabetes. While tests before surgery can spot diabetes, the best way to ensure that the doctors have this essential information is to tell them. A doctor will consider diabetes before prescribing drugs or other treatment, or planning surgery. A surgical team will also need to evaluate the possible effect of any complications of diabetes someone may have, such as heart or kidney problems.

Pregnancy

Bearing a child puts extra demands on the body of the mother. Diabetes makes it more difficult for her body to adjust to these demands, and it can cause problems for both mother and baby. Some mothers may develop a form of diabetes during pregnancy, which is called gestational diabetes. Although this kind of diabetes often disappears after the baby's birth, treatment is still needed during pregnancy to make sure that the diabetes does no harm to either the mother or the fetus.

The baby of a woman whose diabetes is not well-controlled may be unusually large at birth. The risk of premature birth, and problems in the baby such as breathing difficulties, low blood sugar, and death is increased. Uncontrolled diabetes that is present in a mother before she becomes pregnant increases the risk of congenital or inborn defects in the baby.

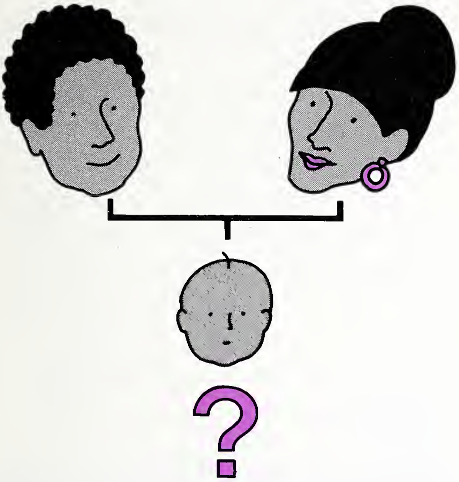
Blood glucose monitoring and treatment with insulin can make it likely that a baby born to a mother with diabetes will be healthy in every way. Oral diabetes drugs are not used during pregnancy because the effects of these drugs on the unborn baby are not known. By working with a doctor who is trained to treat mothers with diabetes, the mother can make sure her blood glucose is normal and at the same time make sure her baby is well nourished.

Birth defects most often occur in the early weeks of pregnancy, when the baby's organs are being formed, and often before the mother has even confirmed that she is pregnant. For this reason, careful diabetes control needs to begin before she becomes pregnant, so that her diabetes will not increase the risk of defects.

Gestational diabetes develops most frequently in the middle and later months of pregnancy, after the time of greatest risk for birth defects. However, the other risks mentioned before are still present, and the mother's diabetes must be controlled. About half of women with gestational diabetes will no longer have abnormal blood glucose tests shortly after they give birth. However, many mothers who have gestational diabetes will develop noninsulin-dependent diabetes later in their lives. Regular check-ups can ensure that if a mother does develop diabetes later, it will be caught and treated quickly.

Will the Child of a Parent With Diabetes Also Have Diabetes?
Scientists estimate that the child of a parent with noninsulin-dependent diabetes has about a

Drinking fluids during illness is especially important for someone with diabetes.



10 to 15 percent chance of developing noninsulin-dependent diabetes. (Diabetes occurs in about 5 percent of the general population.) If both parents have diabetes, the child's risk of having the disease is increased. The health habits of the child through his or her life affect the risk of having diabetes. Obesity, for example, may increase the risk of diabetes or cause it to occur earlier in life.

Noninsulin-dependent diabetes in a parent has no effect on the chances that that person's child will have insulin-dependent diabetes, the more severe form of diabetes.

Stress and Illness

One way the body responds to stress is to increase the level of blood glucose. This response is one of the ways the body equips itself to respond to what causes the stress. In someone who is being treated for diabetes, however, stress may increase the need for treatment to lower blood glucose levels.

Illness such as a cold or flu is a form of physical stress. A doctor can help someone with diabetes plan what to do for a cold or flu. People with or without diabetes can lose fluids when they are ill, so doctors suggest drinking fluids. For someone with diabetes, drinking fluids is especially important. If blood glucose level is high, the body tries to get rid of glucose through urine and this fluid needs to be replaced.

A doctor can help if nausea makes eating or taking oral diabetes drugs a problem. Not eating can increase the risk of low blood glucose, while stopping oral drugs during illness can lead to very high blood glucose. In addition, a doctor may prescribe insulin temporarily for someone with diabetes who cannot take any drugs by mouth.

Drugs prescribed for illnesses other than diabetes can affect blood glucose level. A doctor who knows that his or her patient is taking drugs for diabetes can make sure that any additional drugs pose no special hazard.

Great thirst, rapid weight loss, high fever, or very high urine or blood glucose are signs that blood glucose level is out of control. If a person has these symptoms, a doctor should be called right away.

Like illness, stress that results from losses or conflicts at home or on the job can also affect the control of diabetes. Urine and blood glucose checks can be clues to the effects of stress. If someone finds that stress is making diabetes control difficult, a doctor can help with advice on treatment and may suggest sources of help for coping with stress.

Points to Remember

- *Certain special situations such as pregnancy, surgery, and illness call for extra careful diabetes control.*
- *Special control may require the use of insulin, even in people who don't normally use insulin for control of diabetes.*

Coping With Diabetes

Good diabetes care means daily effort to follow a diet, keep active, and sometimes to take drugs. People who don't have the disease may not be aware of the day-to-day responsibility diabetes involves.

Talking with other people who have diabetes or who treat people with diabetes may help someone who gets tired of daily treatment, or feels alone. The diabetes organizations on the list at the back of this booklet can help locate discussion groups or counselors familiar with diabetes.

The general advice for people with diabetes—to be educated with respect to their health, eat a healthy diet, exercise, and be aware of any changes in health—is the advice doctors urge for any individual who wants to maintain good health. People with or without diabetes can live to a ripe old age, especially if they take care of their health.

Points to Remember

- *Good diabetes care is a day-to-day responsibility.*
- *Local diabetes organizations may have helpful programs in which people with diabetes can exchange experiences and support.*
- *The good health care urged for people with diabetes would be beneficial to anyone who wishes to maintain good health.*

Finding Help

Diabetes is a disease in which the person affected must be responsible for daily care. A doctor who has seen someone in his or her office and has results of medical tests to refer to is the best source of advice on how to carry out this care.

A doctor in family practice or internal medicine can diagnose and treat diabetes. The local chapters of the American Diabetes Association or the Juvenile Diabetes Foundation may have lists of doctors who specialize in treating people with diabetes. Another alternative is to call a local medical society or hospital or find out where the closest university medical center is—that is, a university with a medical school affiliated with a teaching hospital. These centers may have special diabetes clinics or may be able to suggest doctors in the community. Doctors are also listed in the yellow pages of the telephone book—diabetologists specialize in diabetes treatment.

Points to Remember

- *Medical guidance is available from a variety of sources such as diabetes groups, local medical societies and hospitals, and diabetes clinics.*

Printed Information

While information in books and magazines cannot replace a doctor's personal advice, they may help someone understand diabetes and learn about current ideas in diabetes treatment. The American Diabetes Association has brochures about diabetes and diabetes treatment. These publications are written for people with no medical background. The address of the American Diabetes Association is in the resources section at the back of this booklet. Brochures from other organizations are sometimes filed in local public libraries. There are also commercially printed books about diabetes available in book stores and libraries.

Local chapters of the American Diabetes Association, hospitals, and medical centers sometimes sponsor educational programs on diabetes and diabetes treatment. These programs can be very helpful by giving current information and having people available to answer questions. A doctor or local diabetes groups are good sources of information on such programs.

Points to Remember

- *Additional information is available from the American Diabetes Association, in local bookstores and libraries, and from local diabetes programs and groups.*

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15 WEST 16th STREET
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